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THE

PATENT PRESSURE PILE

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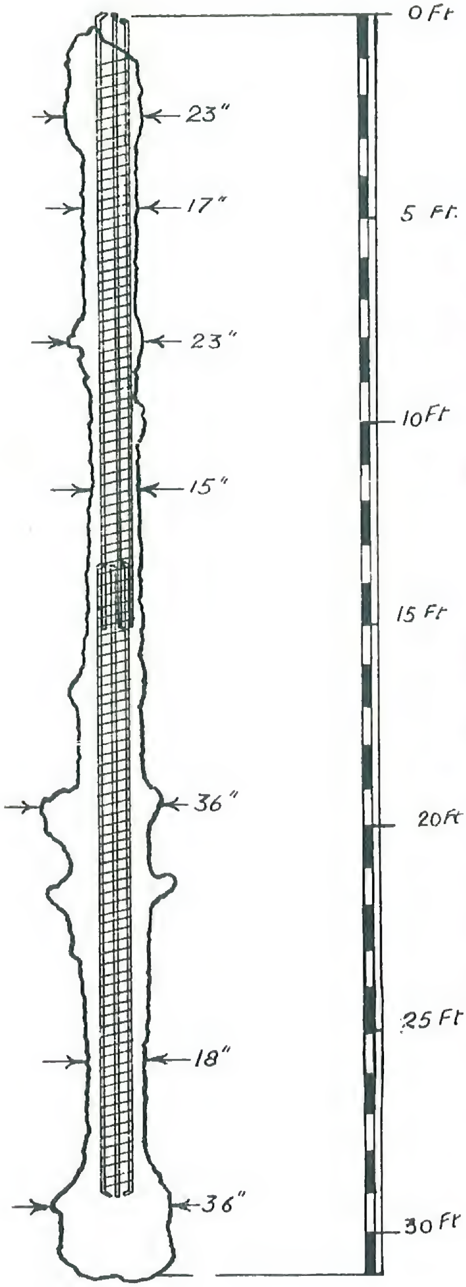
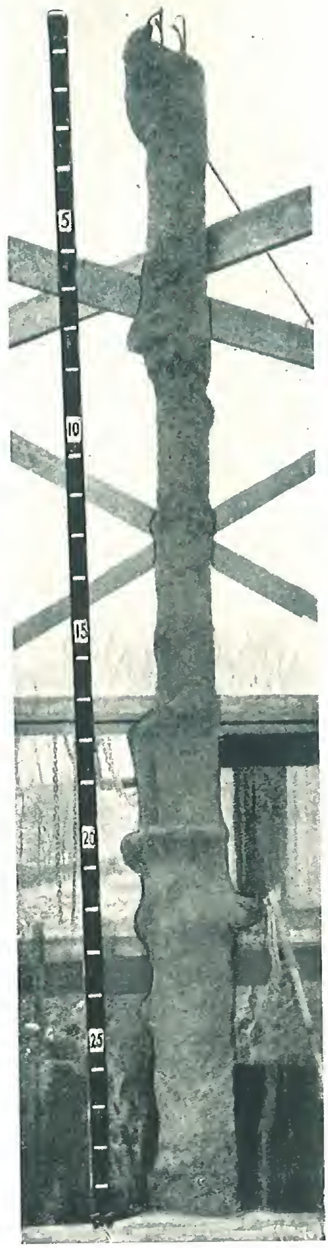




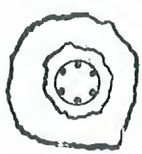


Illustration of a Pressure Pile dug out.

The Patent Pressure Pile.

THE question of foundations is an ever recurring consideration that Engineers and Architects generally have to face.

The vibrations caused by driving piles, the uncertainty as to exact length required, the damage done to the concrete in driving, have all been causes of anxiety at one time or another.

Pressure Piles overcome all such difficulties, the following being some of their advantages :—

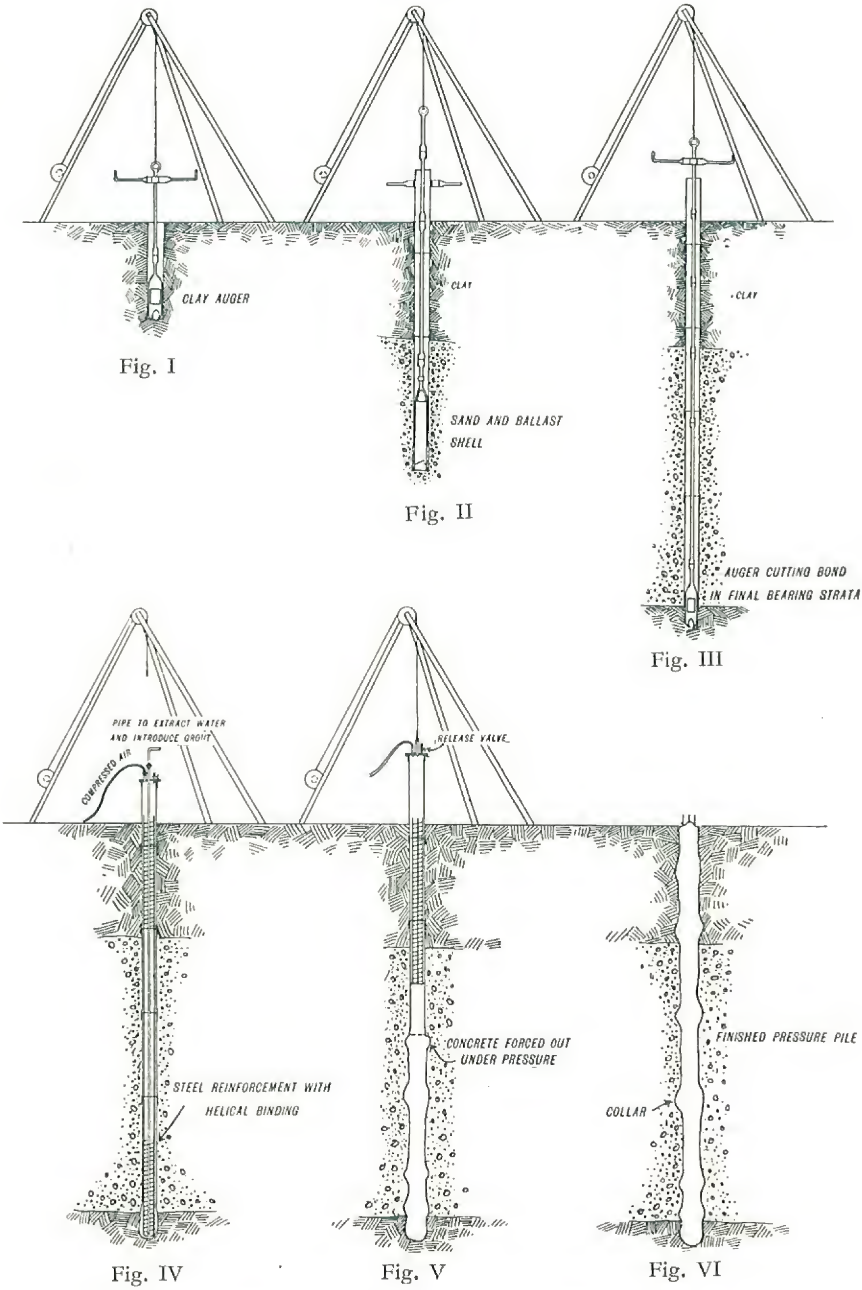
1. **Absence of all vibrations and tremors,** enabling piles to be sunk without danger to adjoining buildings.
2. The underlying stratum of each pile is thoroughly explored so that the exact length of pile can be determined.
3. Steel reinforcements of any desired section and design can be used.
4. The concrete is subject to high pressure, giving a particularly dense mixture.
5. The concrete is compressed into the subsoil, forming collars, etc., giving an extraordinary high skin friction.
6. Each pile is pressed *in situ*, enabling the work to be carried out in a confined area.
7. A minimum of 6-ft. headroom is required, enabling piles to be sunk of any length inside buildings, in cellars, etc.
8. Piles properly reinforced will resist tension and can be used as anchors and ties.
9. Piles can be made plumb or at whatever angle is best suited to the design.
10. The sliding of the foot is prevented in soft bottom by means of a club foot, and on smooth rock surface by cementing the pile into a socket drilled into the rock.

The Pressure Concrete Piles can be employed under the most difficult conditions conceivable ; they comply with the most exacting demands and render possible constructions hitherto impossible.

In this system of piling, heavy boring pipes are sunk in the ground by their own weight, without the use of any driving medium and without jarring of any kind, while the ground is excavated from the pipes in the manner employed by well borers (Figs. I to III). In this way, the underlying stratum is thoroughly explored. This information is invaluable, as it eliminates the indeterminate factor so prominent in the other piling systems. The sure knowledge that the pile is resting on a stratum of adequate bearing capacity is of great value to the designer, and a source of satisfaction to every one connected with the structure. An added advantage is the certainty with which piles can be kept either plumb, or at whatever angle is best suited to the design.

On reaching a bearing stratum, such as firm clay, or rock, boring operations are continued for two or three feet, for the further exploration of the stratum and for the provision of an enlarged base or key. The boring tubes, however, are kept off the bottom of the hole. Steel reinforcement of any desired design is then lowered and fixed at the correct height for the rods to be properly embedded. A pressure cap is now screwed on, and through a nozzle in the cap compressed air is admitted, and all subsoil water is driven out through a lowered pipe (Fig. IV). This operation ensures that during placing, the concrete is kept free from the injurious effects of subsoil water, so that the concrete is a thoroughly reliable product. In fact, the conditions for placing the concrete are very much the same as those obtained in the concreting of an ordinary column above ground, but in one continuous process.

Cement grout is now introduced under pressure, and air compressed to about 7 atmospheres (over 6 tons per sq. ft.) is admitted. The sides and bottom of the bore below the pipe are thus compressed, and the grout is squeezed tightly into the cavity. Thus a " Club Foot," or " Base," is formed, making a broad foundation to the pile, the diameter of which depends on the strength and compressibility of the bearing stratum. The bearing of the column is thus doubly



Method of sinking Pressure Piles.

assured, for not only has the pile been given a larger footing, but a footing which, as it were, is setting while carrying a high load. Moreover, the severe pressure of the liquid grout searches out and strengthens every weak spot in the neighbourhood of the club foot.

Concrete is then introduced, and once more compressed air is admitted ; the air pressure forces the concrete tightly against the adjoining ground, squeezing into all the weak spots, while at the same time compressing the ground round the pile, thus increasing the diameter of the pile (Fig. V). By the upward pressure of the air on the cap, and with the occasional assistance of a jack, the pipe is lifted, but care is taken that the bottom of the pipe is always well below the top of the concrete, so that there is no possibility of soil or subsoil water getting into the space to be occupied by concrete. This process is repeated until the pipe lifts of its own accord. When a soft layer of soil is encountered " collars " of large diameter can be formed, thereby adding considerably to the load-bearing capacity of the pile. As the concrete nears the top, pressure is gradually reduced so as not to increase the size of the pile unnecessarily at the top. In this way a reinforced concrete column cast *in situ*, is made, without jarring of any kind, having a base several times the area of the pile, and made under conditions which are bound to give an extraordinary high skin friction (Fig. VI).

The adaptability of this process is, perhaps, its outstanding feature ; these piles, in reality, reinforced concrete columns cast *in situ* under the best conditions, have been made and inserted at any desired angle with as little as six feet of head room in the minimum of space, and in the most trying circumstances. Structures, hitherto impossible on account of foundation difficulties now become practicable. The absence of vibrations, or jarring of any kind, eliminates the grave risk of failure through cracks or damage to adjoining buildings, or collapse of roads. The absence of steam hammers eliminates noise and smoke,

and thus does away with a serious nuisance which often leads to injunctions and legal hindrances generally.

A Special feature of this process is the ease and certainty with which underpinning work can now be carried out where formerly space, headroom, etc., made such operations prohibitive, or, at best, uncertain of achieving the desired result.

The use of this process simplifies the design of piled foundations, and the value of the designers' work is greatly enhanced by the elimination of the usual indeterminable factors. The safe load on a pile depends on—

(*a*) The intrinsic strength of the pile;

(*b*) The resistance of the ground to which the pile has penetrated, and

(*c*) The skin friction between the sides of perimeter of the pile and the ground it has penetrated.

(*a*) The intrinsic strength of the Patent Pressure Pile is whatever the designer likes to make it, compatible with the strength of an ordinary reinforced concrete column. In this respect it is interesting to note that the finished diameter of a Pressure Pile, apart from " Collars " formed round it in weak strata, is generally $1\frac{1}{4}$ times the diameter of the boring pipes, due to the compression of the surrounding soil by pressure. The absence of injurious subsoil water during placing, the compactness of the concrete continuously tested under pressure, and the absence of jarring of other disturbing influences on the concrete during and after the setting, combine to form the most ideal condition for casting a reinforced concrete column. That, and the certainty that the reinforcement is thoroughly embedded in pressure concrete of extraordinary density, tends to produce a column upon whose intrinsic strength the designer can thoroughly rely.

(*b*) The nature of the material to which the pile has penetrated is as certain as in an openly excavated foundation, while it is further tested by the load it takes under

pressure during the introduction of the grout. The formation of the club foot, moreover, ensures a far greater bearing area. It is also interesting to note the great advantage this process possesses when a layer of rock is encountered unexpectedly. In the case of pre-cast concrete piles, the sudden jarring may seriously damage the pile without yielding any information whether such damage has occurred ; it may, moreover, happen, as it sometimes does, that the layer of rock encountered is very thin and has no real bearing capacity. An even more serious danger is the possibility of encountering a large stone, or, in the case of made-up ground, old timber, roots, brickwork, etc. These dangers are completely eliminated in the Patent Pressure Piling System, as the assumed bearing stratum is always explored for a further two or three feet at least.

(*c*) An extraordinarily high skin friction is assured by the concrete being pressed tightly into the subsoil ; and soft layers, far from weakening the total skin friction, as they do in the case of all driven piles, in this process actually add to the frictional bearing capacity by yielding to the formation of thickened portions of the pile, and " Collars," which are sometimes many times the diameter of the pile itself. Nor is there any weakening influence through skin destruction, as must sometimes have gravely adverse effects in the case of pre-cast concrete piles.

Particularly gratifying to the engineer is the almost unlimited scope which this process gives, since the Patent Pressure Piles, by the simplicity and directness of their construction, can be cast in any position, at any angle, as compression members as well as tension members.

Another element of uncertainty completely eliminated in this process—the length of piles to be used—is of importance both to designer and contractor. A trial bore only gives information at the site of the bore as to length of pile. With pre-cast concrete piles, the length decided upon must of necessity be a maximum to suit conditions upon the site. This often leads to the necessity of cutting a

length off the top of the pile—an irksome, wasteful and costly operation, always attended by the possibility of inflicting permanent injury to the pile itself. The opposite case of having driven too short a pile is just as bad because splicing of piles can never be really satisfactory, and leads to serious delays in the work.

In the Patent Pressure Piling process, not only the concrete but also the reinforcement can be placed to the exact levels and dimensions to suit each individual pile. Furthermore, pre-cast piles require expensive moulds, and a large surface area for casting the piles. In most cases this area is quite unobtainable at the site, with consequent difficulty and expense of transport and handling, together with the provision of cumbersome pile driving plant. All this is eliminated by the Patent Pressure Pile Process.

A further great advantage obtained by using Patent Pressure Piles is where it is desired to cast either an enlarged pile cap, or to connect beams or floors to the pile. To meet these conditions with an ordinary reinforced pile, the top three or four feet of the pile has to be broken away to expose the reinforcement and additional reinforcement spliced on, and the concrete made good—always an unsatisfactory procedure, and entailing an additional expense of anything up to 40s. per pile. With the Patent Pressure Pile System, the rods can be inserted of any additional length required for effecting proper connection to the beam or cap, bent over to the required angle after withdrawing the casing and the whole cap or beam cast *in situ*, with the pile, thereby ensuring a proper bond and adding considerably to the strength of the connection.

The system has been extensively adopted for some years on the Continent, and has received the favourable verdict of experts wherever used. As regards usage in Great Britain we append a few particulars of typical cases.

Any type of Reinforcement can be used in these Piles.

BELFAST CUSTOMS HOUSE.

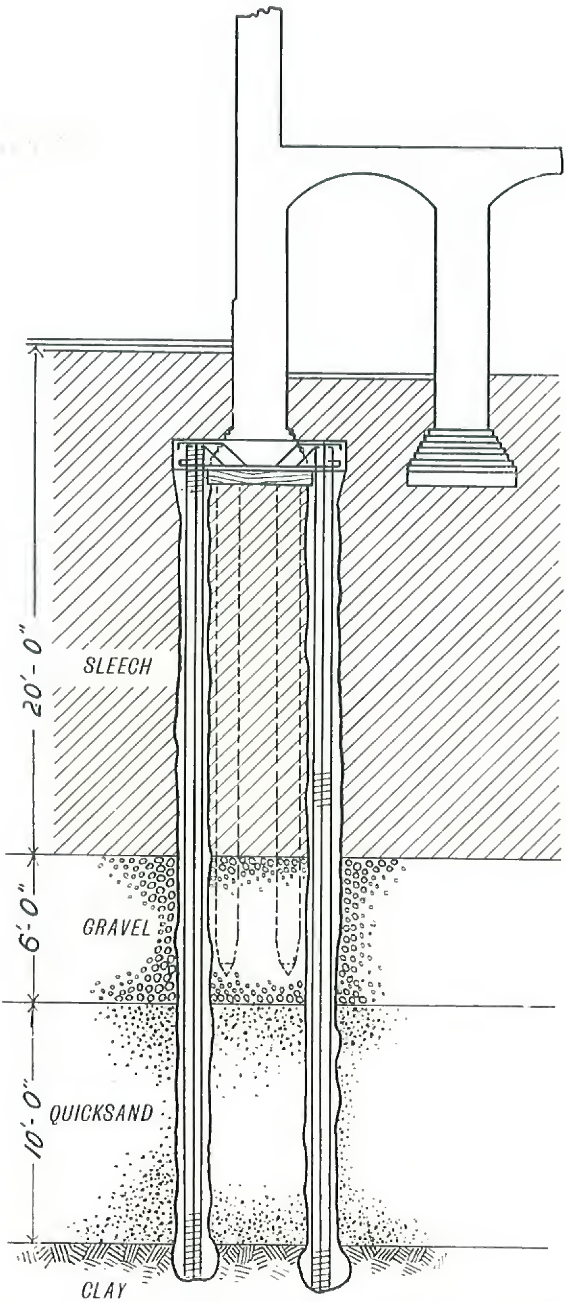
This important edifice, jointly occupied by H.M. Government and the Northern Government of Ireland, is a very heavy building, with thick masonry walls, the entire basement being vaulted in masonry and brickwork. The building was carried on substantial stone footings, resting on a timber grillage, supported by wooden piles driven into the notorious "sleech" (comparable with the semi-solidified mud of the Thames foreshore known as "bungum") which covers a considerable area of riverside Belfast. For some years settlements in the building had been causing great anxiety, and investigation of the foundations showed that decomposition had taken place to such an extent that in some cases the grillage and pile heads had completely rotted away, compelling the greater portion of the building to be vacated. After close investigation H.M. Office of Works and the Department of Public Works, Northern Ireland, jointly decided that the only way to save the building was to adopt the Patent Pressure Pile System, and this was done, with the most satisfactory results. The *modus operandi* adopted was to sink our reinforced concrete Pressure Piles at short distances apart in pairs, placing one pile on the outside of the stone footings and the other one on the inside as closely as possible to the foundation course. The tops of these piles were then connected by a longitudinal concrete mat, upon which was placed pre-cast reinforced transverse beams a short distance below the existing stone footings. Steel wedges were then introduced, and the whole weight of the building transferred to the new foundations, the voids being then thoroughly grouted up (under pressure when necessary).

The walls above the footings being in a bad state, by reason of the numerous fractures, the old mortar joints were raked out and stopped, all loose stones, as far as possible, being jacked up to their original position, and then our cementation process applied. By these methods an expensive building has been saved from demolition, and placed on a new concrete foundation, supported by reinforced concrete piles of an average length of 35 to 40 feet sunk right through the "sleech" to a firm stratum. It is

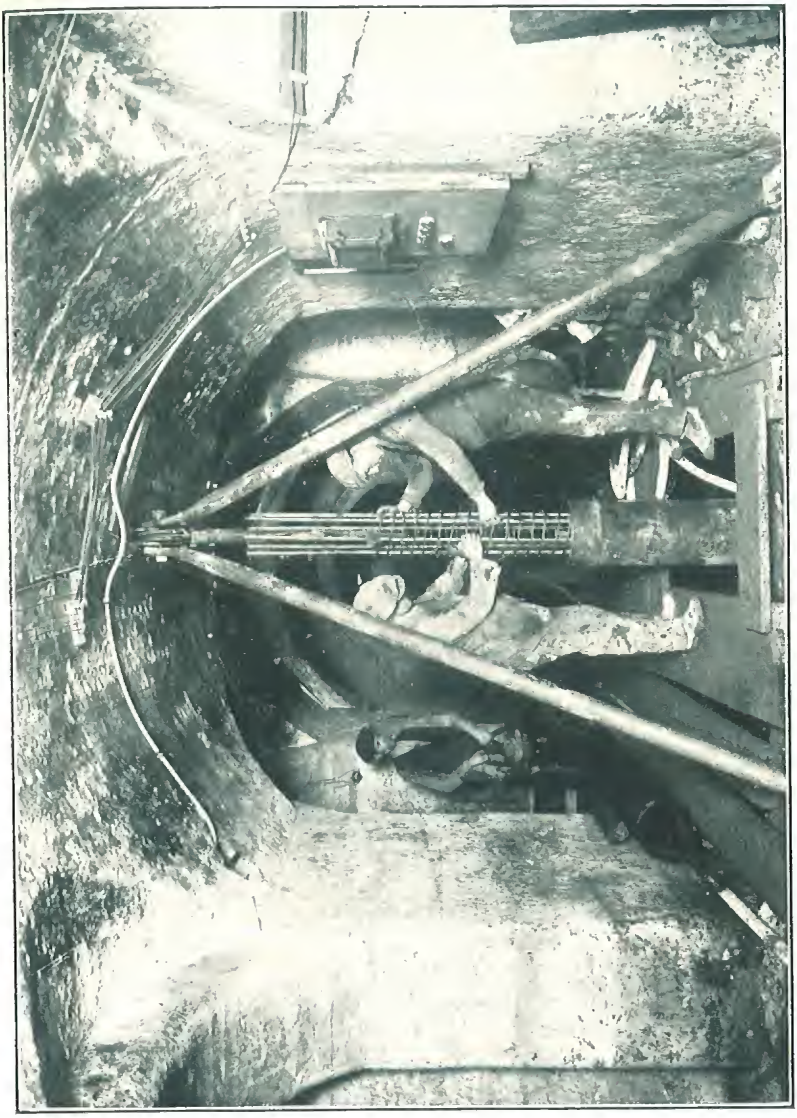
important to note that in some cases the internal piles were inserted with as little as six feet headroom under the vaulting.

Belfast Customs House before underpinned by Pressure Piles—1926-7.

It was quite impossible to insert the ordinary pre-cast concrete pile inside this building, and to have even attempted the use of this class of pile either externally or internally—assuming such use were otherwise possible—would have certainly caused the speedy collapse of the building, consequent upon the vibration and disturbance due to driving.

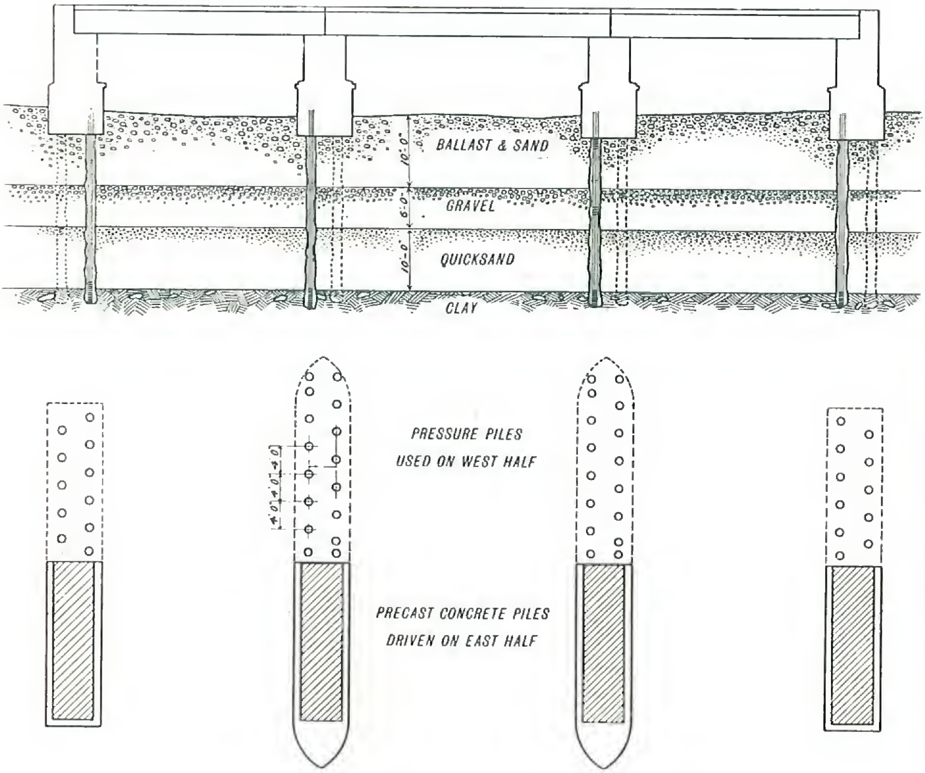


Showing method of underpinning adopted in Belfast Customs House.



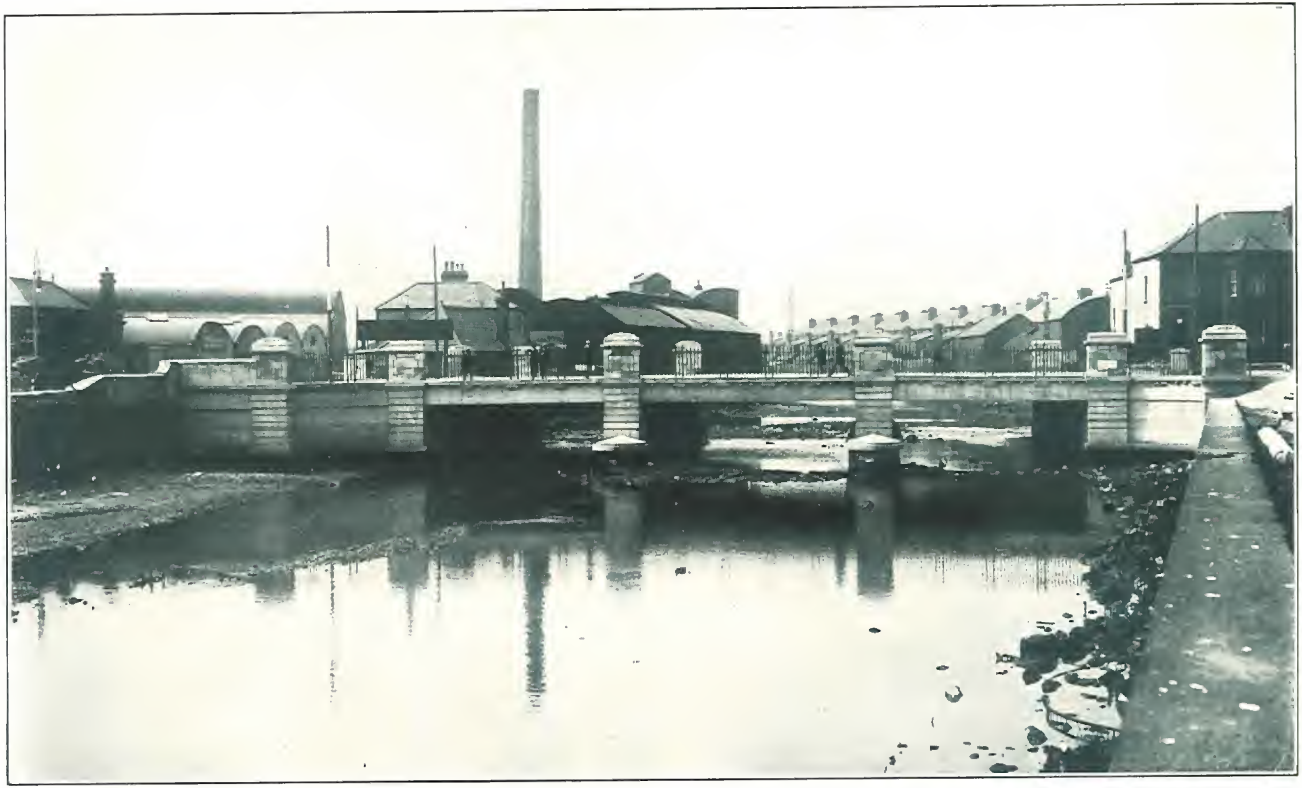
Placing the reinforcement for Pressure Piles with limited head room.

Archway in the Basement of the Belfast Customs House.



ANNESLEY BRIDGE, DUBLIN.

The reconstruction of this well-known bridge, which carried a double line of electric tramways, and very heavy road traffic over the River Tolka, involved considerable difficulty by reason of the sub-soil being found to be of so difficult and unsatisfactory a character that it became impossible to drive ordinary reinforced piles, and the use of same had to be abandoned. Under these circumstances the Patent Pressure Pile System was recommended by the City Engineer as essential and the Commissioners' consent being obtained, the desired number of piles was successfully sunk, thus enabling the reconstruction to proceed with the minimum delay. Under the conditions found to exist the only alternative to our system of piling would have been to sink cylinders under compressed air to a satisfactory stratum—a most expensive and tedious process.



Annesley Bridge built upon Pressure Piles after pre-cast piles had been abandoned—1927.

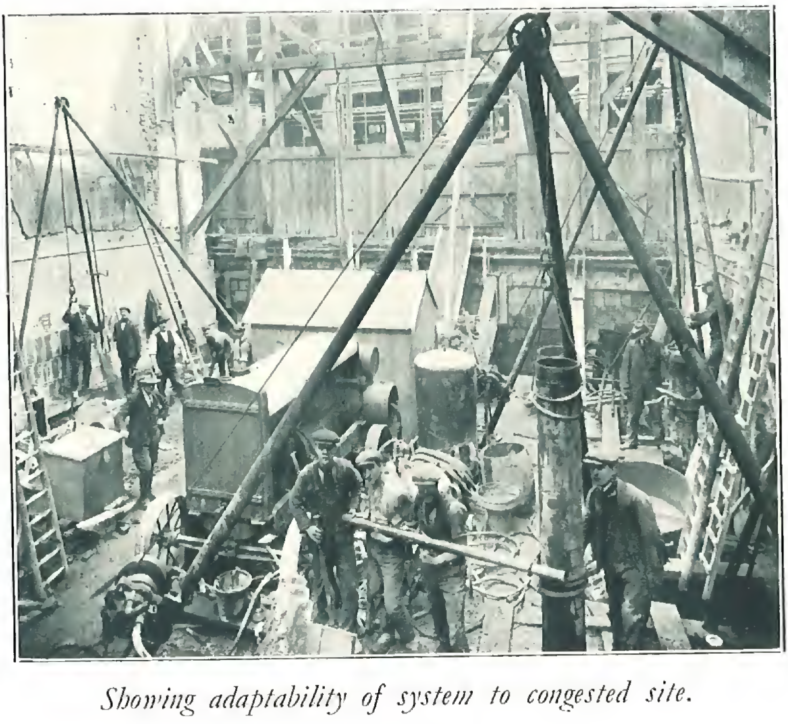
HEAVY WAREHOUSE, THAMES FORESHORE, CITY OF LONDON.

The conditions met with in this instance are, unfortunately, only too common in our large cities—namely, a proposed new basement considerably below adjacent street levels, bad ground—necessitating piling, and a considerable degree of uncertainty as to the stability of adjoining premises.

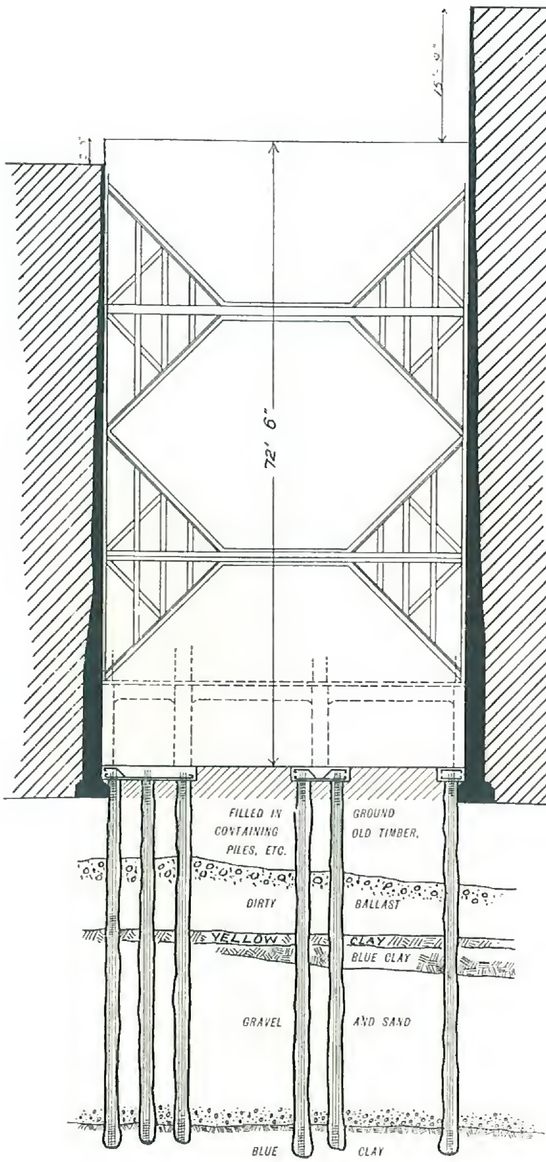
Ordinary piling being impossible, probably the most usual course in a situation of this character is to make a concrete raft over the site, and to restrict the height of the building to the carrying capacity of the raft. By the adoption of Patent Pressure Piling it has been made possible to design a building of much greater height, and, consequently, greater floorletting area, than would otherwise have been possible, and so add to the site a value out of all proportion to the cost of the piles.

Site restrictions such as the foregoing have always in the past proved a bugbear to Architects and Engineers, by reason of serious complaints arising from noise, vibration, damage to adjoining structures, subsidence of streets, etc. The Patent Pressure Pile System stands alone in overcoming all the inherent objections to ordinary piling under these circumstances, thereby enabling owners to now reap the full benefit of valuable sites by their Architects being able to design, unfettered by considerations which have hitherto had to be taken seriously into account.

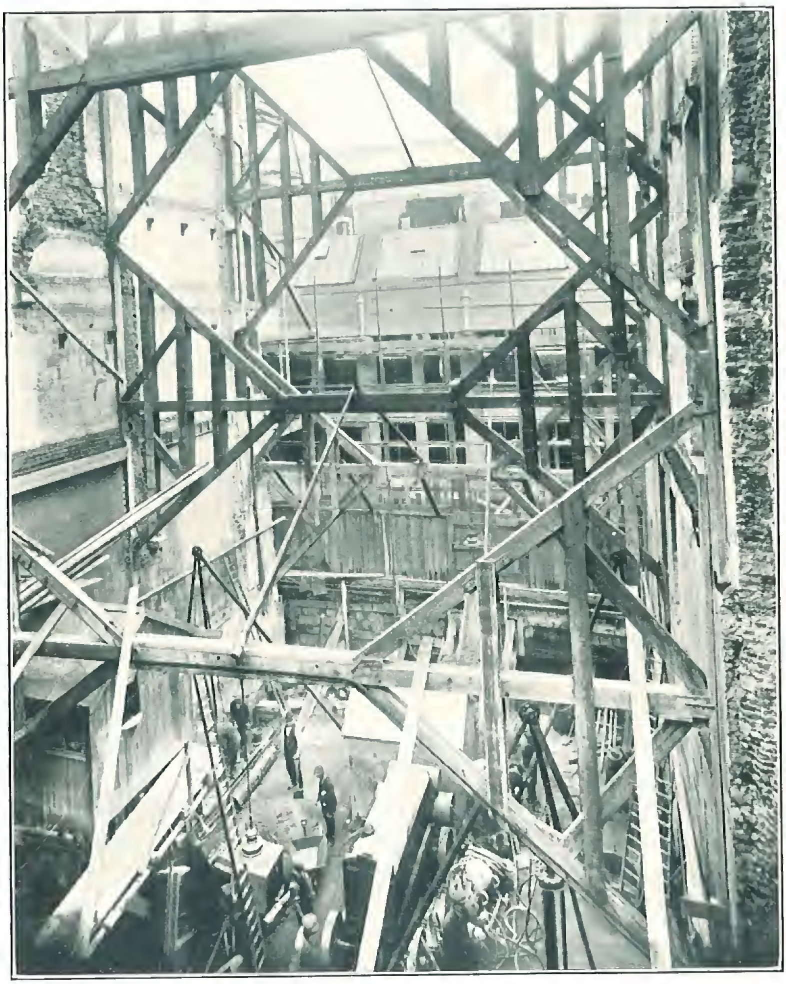
Compressed air being applied to concrete.



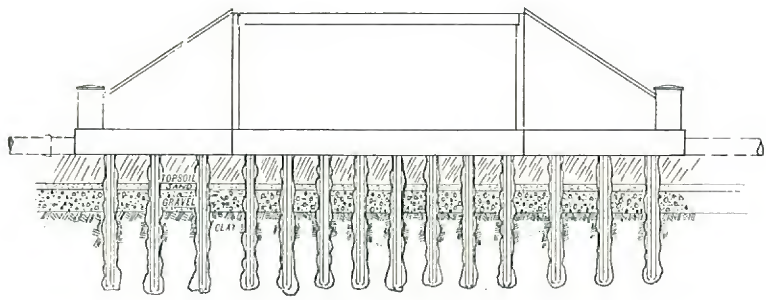
Showing adaptability of system to congested site.



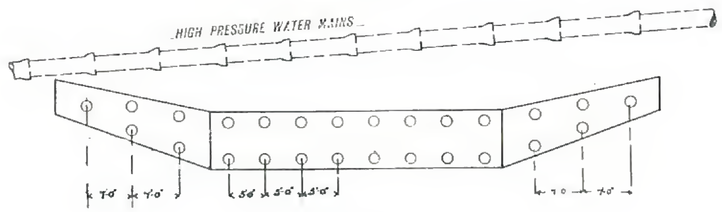
Section showing heights of adjoining buildings and position of Pressure Piles.



General view of site of warehouse, Crane Lane, Thames foreshore, City of London—1928.



ELEVATION



PLAN

NEW EXTENSION TO SOUTHERN RAILWAY.
SUTTON—WIMBLEDON.

This extension had to be constructed to suit local conditions; the lines had to be laid on a "made up" bank, some 15—20 ft. high. It was found that the sub-soil was chiefly running sand, loose gravel, etc.; it was necessary, therefore, that Piling be used, but owing to the close proximity to the new foundations, and of a 30-in. High Pressure Water Main, only 6 ins. under the ground, it was essential to use some system of Piling which eliminated vibrations.

The Pressure Pile was therefore used. Not only for the bridge foundations, but also for the wing wall and retaining wall foundations, where the ground was of a swampy nature. Pressure Piles were sunk within 3 ft. of the High Pressure Water Main without damaging in any way the pipe line.

Some 200 Pressure Piles were used for bridge and retaining wall foundations.

Pressure Piles were used under both abutments.

A heavy retaining wall carried on Pressure Piles.

Sutton-Wimbledon Extension—1928.

THE SCOTTISH LEGAL LIFE ASSURANCE SOCIETY BUILDING, GLASGOW.

The site of this building covers an area of over half an acre, right in the heart of the city of Glasgow, with lofty buildings on all sides.

Pressure Piles were used along the sides adjoining Bothwell Lane, where the basement is 18 ft. below street level, with high buildings on the opposite side of the narrow laneway.

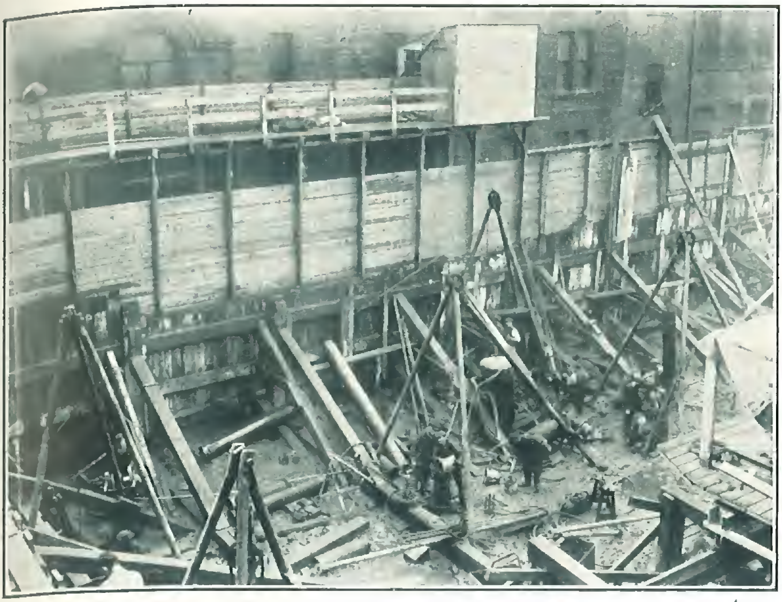
From borings made on the site it was found that the bed of solid blue clay dipped towards Bothwell Lane, being approximately 42 ft. below foundations at that side. By adopting Pressure Piles here, a safe bearing strata was assured and the element of doubt, as to whether the piles had reached a temporary obstruction or firm strata, was eliminated.

Several large stones and boulders were found in the top strata which were removed as the boring proceeded; with driven piles such boulders tend to deflect the piles from their proper alignment, causing distortion and setting up stresses liable to damage the concrete and so weaken the piles.

One of the Pressure Piles 43 ft. long, penetrating 3 ft. into the clay, was tested 21 days after the concrete was poured. The total load placed upon the pile was 67 tons.

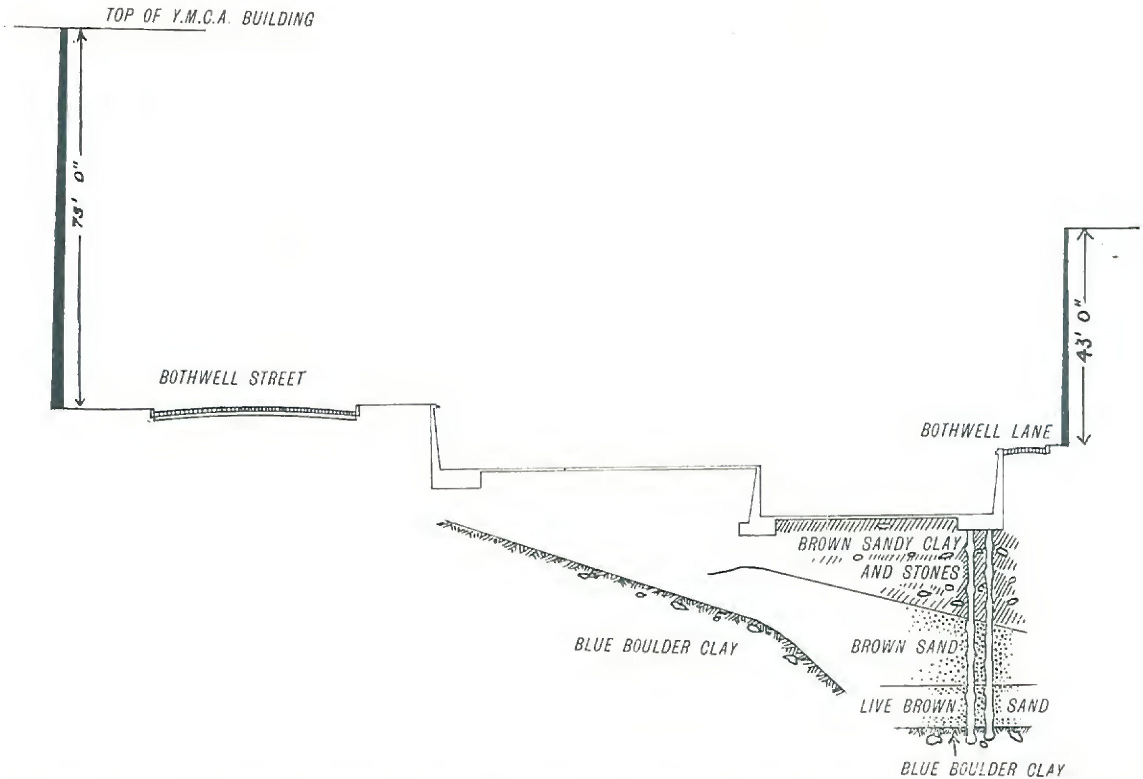
Extract from letter from the Engineers, Messrs. Warren & Stuart, Glasgow:

> "That during the period of the test no subsidence or deflection of the pile is shown.
>
> "On first loading there was a small deflection which disappeared on removal of the load, and is accounted for by the strain on the pile. The test, therefore, is satisfactory."

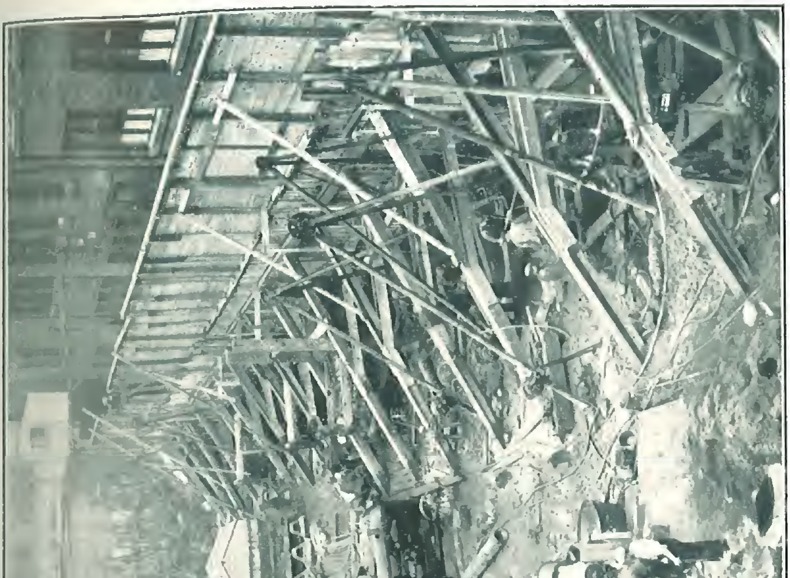


Pressure Piles being sunk along Bothwell Lane.

Precast Piles often necessitate wasteful cutting.

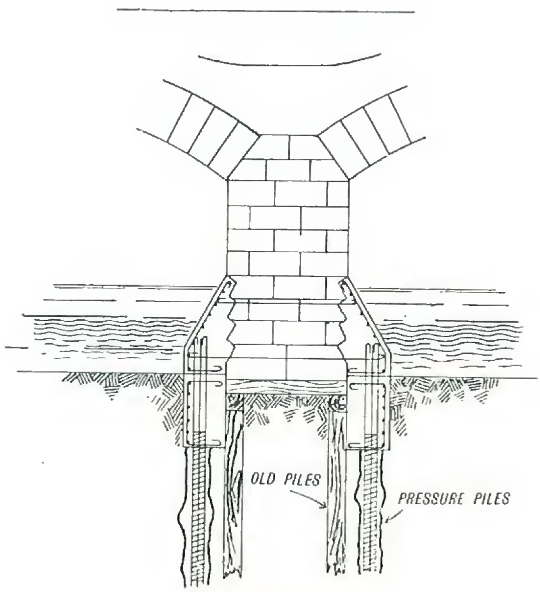


Cross Section of site showing heights of adjoining buildings and position of Pressure Piles.



General view of site showing work in progress.

The Scottish Legal Life Assurance Society Building, Glasgow
—1928.



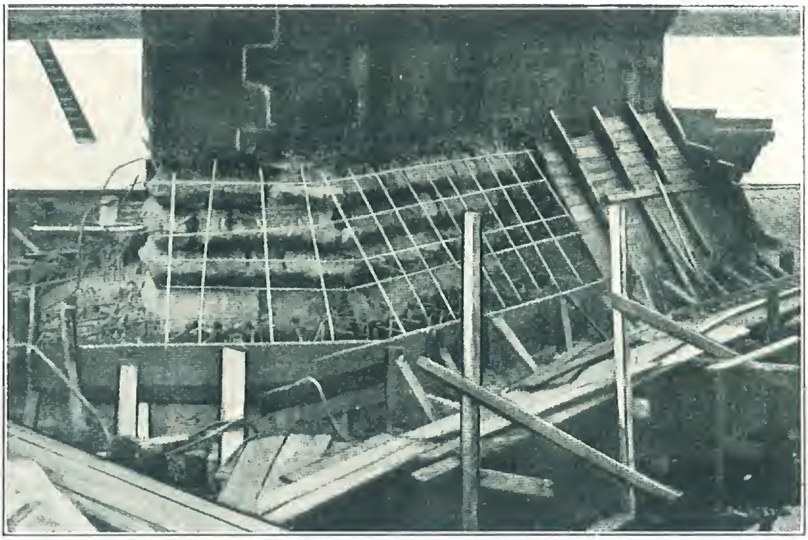
RAILWAY BRIDGE PIER.

The above pier carries a railway bridge over a canal on the Continent. It was found necessary to deepen the canal to take larger barges, and consequently the piers had to be strengthened.

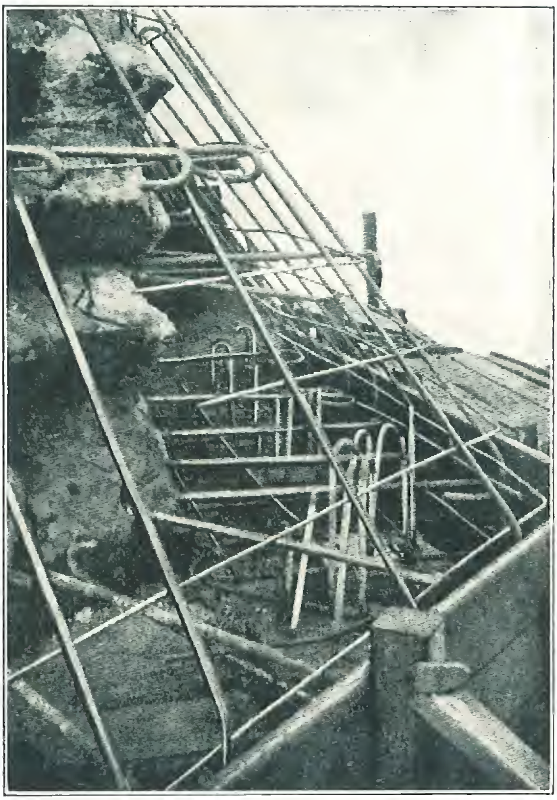
As it was impossible to drive piles under the arches and to eliminate the risk of settlement from vibrations, Pressure Piles were sunk around the piers.

A bond was made to the existing piers by cutting grooves in the old masonry and by drilling holes through the piers through which reinforcement was passed, the latter being grouted in under pressure. The whole making a homogeneous mass with the old pier.

The same method could be applied to any pier or abutment that had subsided, the absence of vibration in this case being an important consideration in favour of Pressure Piles.



Bonding Pressure Piles to existing pier.



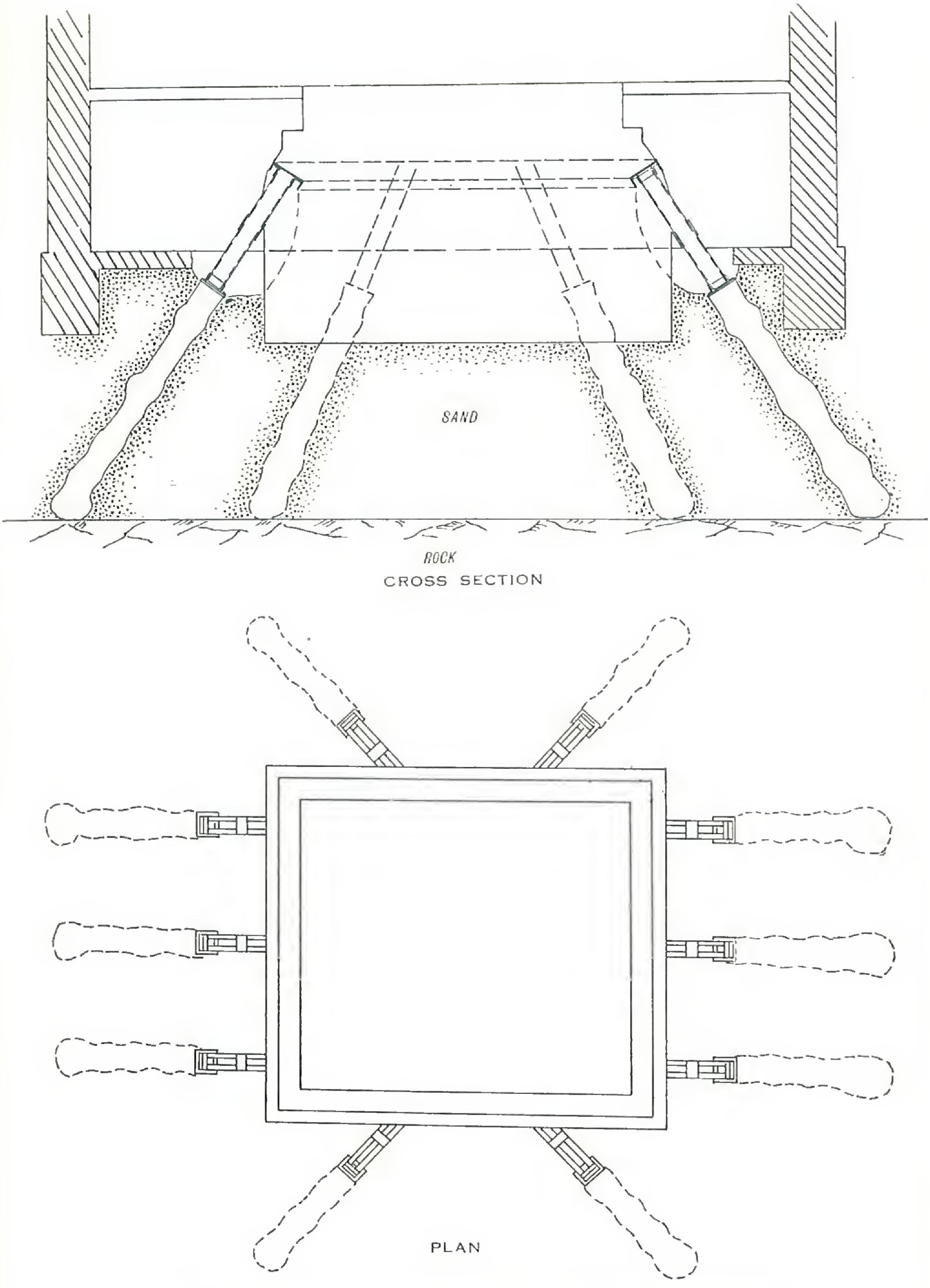
Detail of reinforcement.

HEAVY ENGINE FOUNDATION.

The fact that foundations are underground, and so out of sight, is often the cause for their not receiving more careful consideration.

The above example shows an engine foundation at the Erlangen Municipal Electric Works which was laid on sand and had settled owing to the vibration set up by the engine.

Pressure Piles were sunk on all sides to rock level, and inclined so as to resist the stroke of the engine. A limited amount of head-room, the importance of reaching a solid stratum and lack of vibration necessitated adopting this method.



Plan and Cross Section of Heavy Engine Foundation.

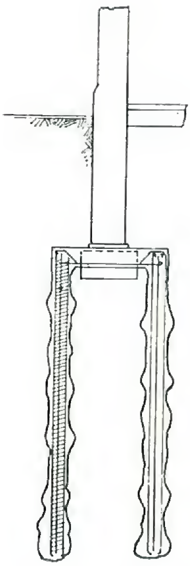


Fig. I

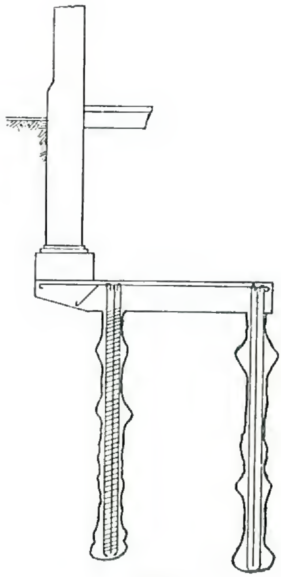


Fig. II

BUILDING FOUNDATIONS.

With present day traffic and the presence of underground railways and works it is no uncommon occurrence for the foundations of buildings to subside.

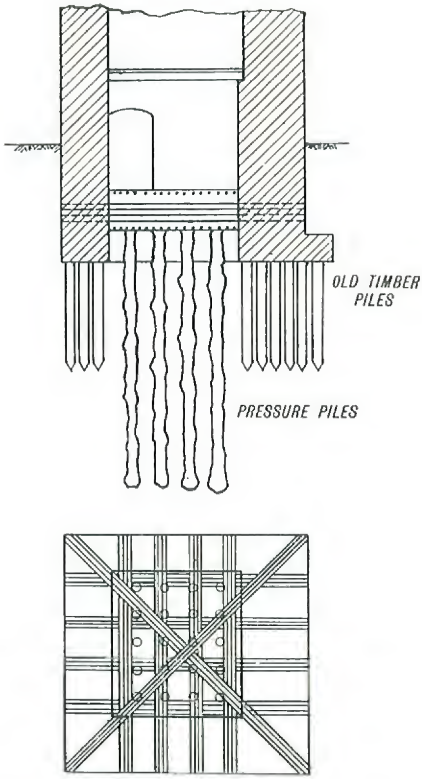
As a remedy for such cases the Pressure Pile is ideal, being the only pile that can be used with safety.

The above sketches show two methods of carrying out the work :—

FIG. 1. Pressure Piles sunk on both sides of the foundation, the load being transmitted to them by a cross beam.

FIG. 2. Taking the weight of the wall on a cantilever, the downward thrust being transmitted to the pile nearest the foundation, the further pile, acting as an anchor, being suitably reinforced and containing collars and club foot to increase the friction.

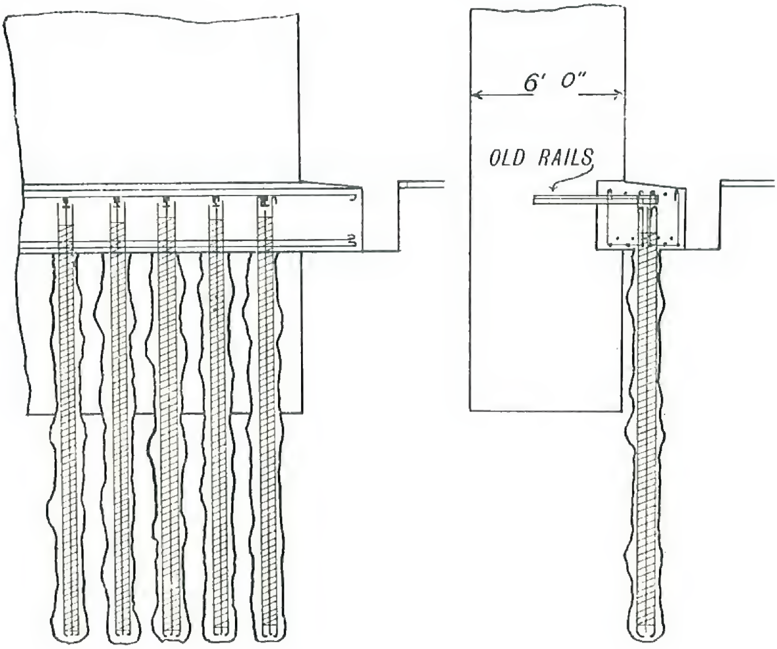
This work can be done inside a building with a minimum headroom of 6 ft.



TOWERS, CHIMNEYS, ETC.

Owing to the excessive height of towers, belfries, chimneys, monuments, etc., and consequent great weight, the foundations frequently settle.

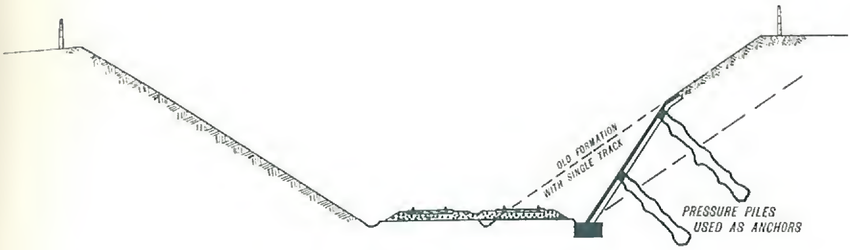
The above example shows one method of tackling the proposition. First sinking sufficient Pressure Piles inside the tower and on top of these forming a reinforced concrete raft. The load is then transmitted to the raft by means of steel joists, the whole being later embedded in concrete.



MASSIVE CONCRETE WALL.

In cases where it is not always possible or advisable to underpin the foundations, a satisfactory remedy can be obtained as shown in above sketch.

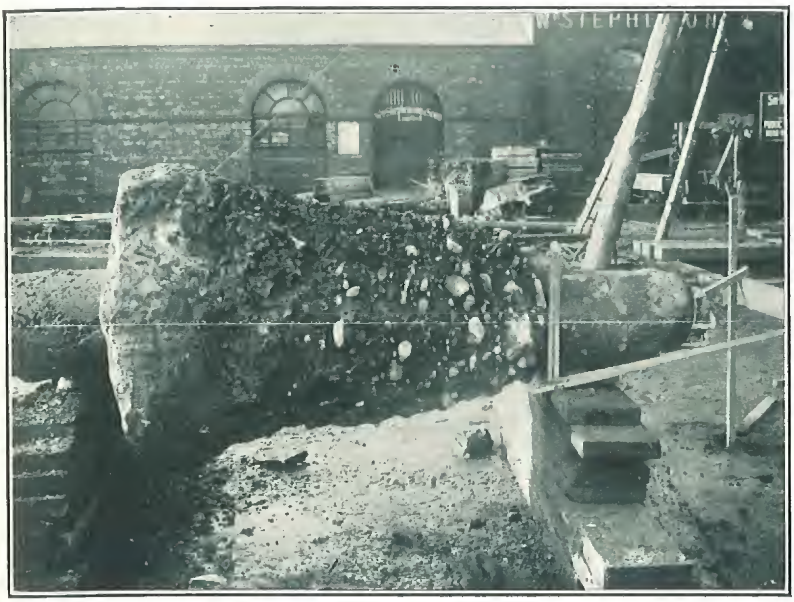
A key is cut in the wall, being further strengthened by passing old rail lengths beyond the centre line, the whole being suitably reinforced to transmit the load to the Pressure Piles.



RAILWAY CUTTING.

When it is necessary to steepen the sides of a railway cutting, or where treacherous soil is met, in order to obviate the construction of a heavy retaining wall. Pressure Piles can be sunk as anchors, joined together with cross beams, and the intervening spaces either pitched with masonry or filled with reinforced concrete, depending upon the pressure from the embankment.

TEST PILE, BELFAST.



Specimen of " Club Foot " formed on Pressure Piles.

QUAY WALL AND DRY DOCK.

The sketch on opposite page illustrates how Pressure Piles can be used for the construction of a Quay Wall or any deep excavation with a large saving of labour, excavation, and timbering.

The *modus operandi* is as follows :—After the sheet piles have been driven, the earth is excavated to a depth of about 8 ft., a hole is then burnt out of every tenth sheet pile or so and a Pressure Pile forced in, so as to get a firm anchorage beyond the angle of repose of the soil, a concrete longitudinal waling is next poured at this level supporting the sheet piling.

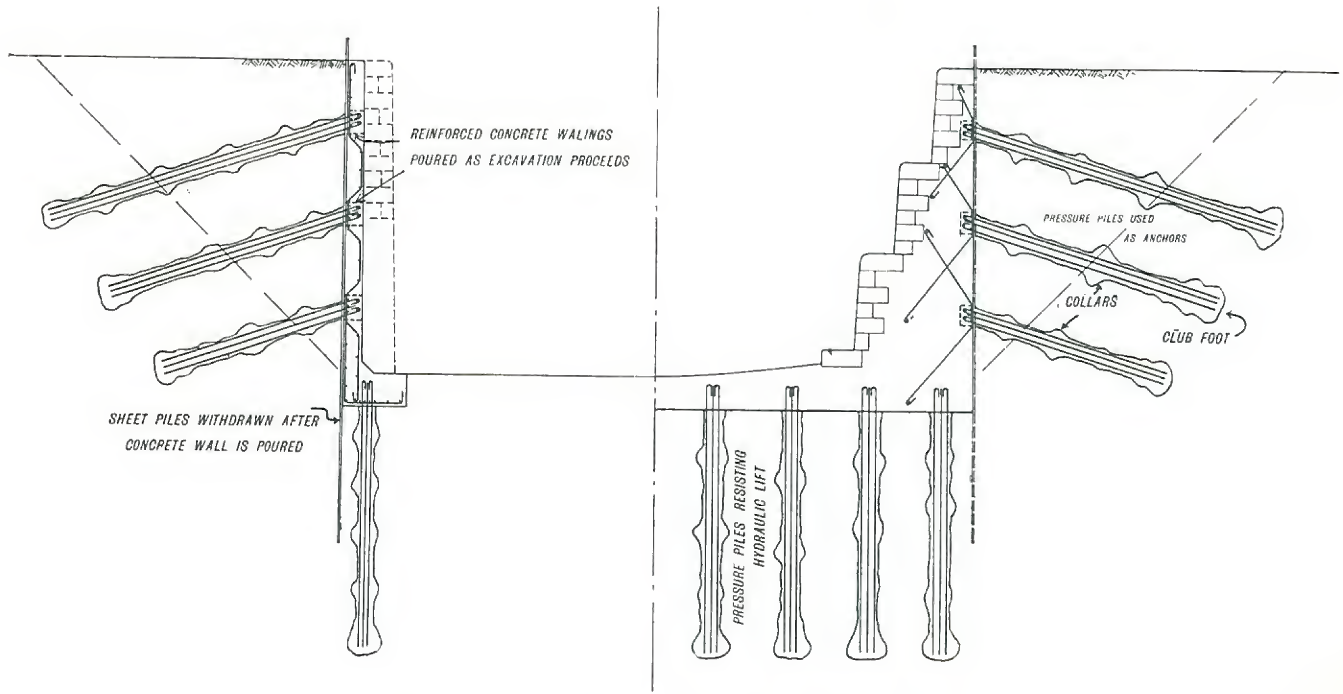
A further excavation is then made, and the same method of procedure adopted until the final depth is arrived at.

The concrete wall is then poured, its reinforcements passing behind the walings, thereby incorporating the Pressure Piles into the finished wall.

The sheet piling is then withdrawn, except those which had been cut to allow the Pressure Piles to pass through.

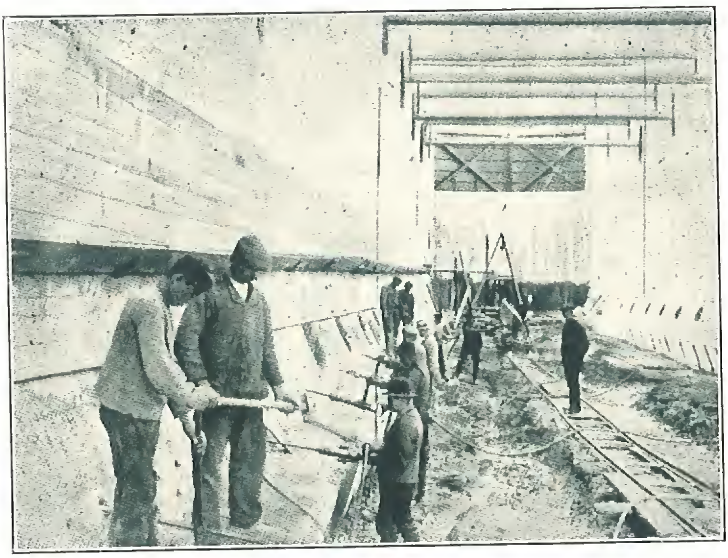
It should be pointed out that by adopting this method all the necessary excavation and filling behind the wall has been obviated, and the excavation inside the wall can be carried out by mechanical grabs as no cross timbering is required.

An additional advantage of using the Pressure Piles in the case of the dry dock, is that such piles can be used as anchors to resist the hydraulic upward pressure.

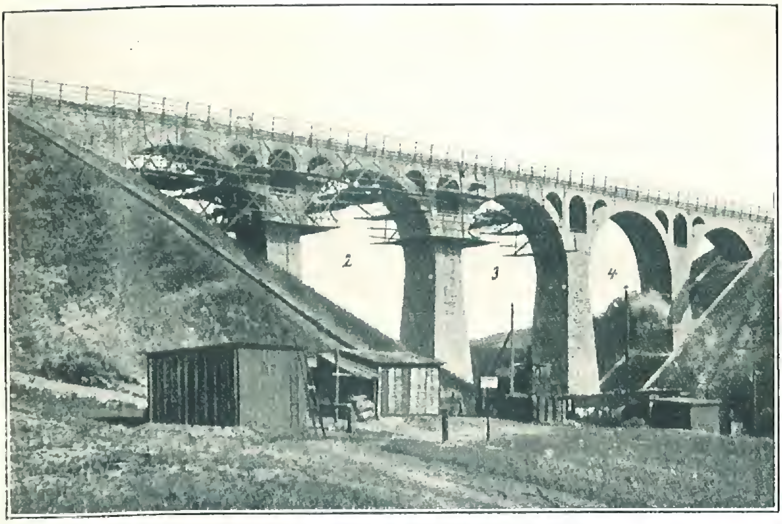


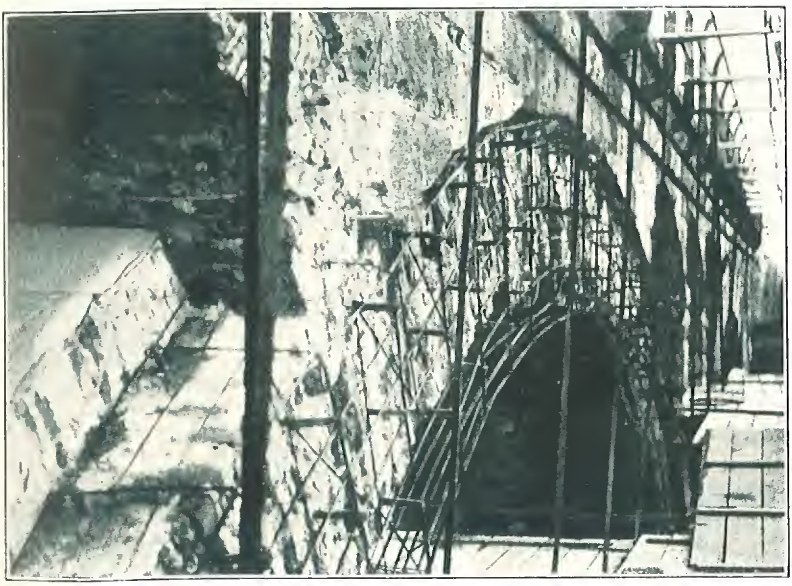
Half Sections of Quay Wall and Dry Dock.

Strengthening a tunnel by forcing in cement grout under pressure.



Holes being cut in lock wall preparatory to cementation.





Repairing arches of railway viaduct.

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